Ubiquitous computing and knowledge management

CROWTHER, P.

Published version

CROWTHER, P. (2006). Ubiquitous computing and knowledge management. International journal of knowledge culture and change management, 6 (2), 77-86.

The International JOURNAL of KNOWLEDGE, CULTURE & CHANGE MANAGEMENT

Ubiquitous Computing and Knowledge Management

Paul Crowther

VOLUME 6

COMMON GROUND

www.Management-Journal.com

INTERNATIONAL JOURNAL OF KNOWLEDGE, CULTURE AND CHANGE MANAGEMENT
http://www.Management-Journal.com

First published in 2006 in Melbourne, Australia by Common Ground Publishing Pty Ltd
www.CommonGroundPublishing.com.

ISSN: 1447-9524 (print), 1447-9575 (online)
Publisher Site: http://www.Management-Journal.com

The INTERNATIONAL JOURNAL OF KNOWLEDGE, CULTURE AND CHANGE MANAGEMENT is a peer refereed journal. Full papers submitted for publication are refereed by Associate Editors through anonymous referee processes.

Typeset in Common Ground Markup Language using CGCreator multichannel typesetting system
http://www.CommonGroundSoftware.com.

Ubiquitous Computing and Knowledge Management

Applications of MOBIlearn

Paul Crowther, Sheffield Hallam University, United Kingdom

Abstract: MOBIlearn is a large European research project to develop a mobile learning system to facilitate formal, non formal and informal learning. The project has two primary objectives: • Develop a methodology for creating mobile learning scenarios and producing learning objects to implement them. • Develop the technology to deliver the learning objects to users via mobile computing devices. This paper will concentrate the MOBIlearn health care domain. One of this applications main objectives is managing and sharing of tacit knowledge. Using the system participants discuss case studies and alternative approaches to specific problems are evaluated and documented. This is then used and extended in future case studies. In a mobile learning environment, individual health workers can use the system to either advanced their skills, or in a 'live' incident, use it for reference and indeed call for backup.

Keywords: m-learning, Knowledge Management, Ubiquitous Computing, Community of Practice

Introduction

THIS WORK IS based on experiences from the MOBIlearn project funded by the European Framework V IST programme. Learners today want to learn when and where they want, in formal, non-formal and informal ways (Brand et al, 2002). MOBIlearn meets learners' requirements utilising mobile communications and personal computing devices such as a PDA, smart phone or portable computer. In other, words mobile or ubiquitous computing.

A key part of the MOBIlearn project is the integration of new technologies in education. It aims at improving access to knowledge for selected target users giving them ubiquitous access to appropriate learning objects (Taylor, 2003). Initially the MOBIlearn requirements were provided by four scenarios:

- A visit to an art Gallery;
- Access to training and basic medical knowledge in a hospital;
- A master's course in business administration;
- University orientation for new students

The aim of MOBIlearn is therefore '...the creation of a virtual network for the diffusion of knowledge and learning via a mobile environment ... to ... demonstrate the convergence and merging of learning supported by new technology, knowledge management, and new forms of mobile communication.' (MOBIlearn 2002, Annex 1, p. 7).

The pedagogic basis of the system is the learner who interacts with a mobile learning portal to access learning objects and participate in online activities. Each of the test scenarios has its own learning objects. However all these learning objects need to be delivered in a flexible way to a variety of devices (Stone, 2003). For example the interface characteristics of a tablet computer are far different from that of a PDA. One challenge is therefore to deliver the correct interface to a learning object or oblette to the mobile device.

There are a variety of ways of delivering learning objects to devices with differing characteristics including re-authoring, transcoding and the functional-based object model (Kinshuk and Goh, 2003). Ideally an open standard should be used to allow different content providers to make their material available on mobile devices. The approach taken in MOBIlearn is to use re-authoring where page descriptions are held as XML which is compatible with the standard suggested by Loidl (2005).

The requirements for MOBIlearn were developed using a scenario driven methodology (Beynon-Davies and Holmes, 2002). A scenario was developed for each of the areas mentioned above and the requirements extracted with specific attention to those common to all applications. These were documented using a Volere template (Robertson and Robertson, 2001) based database which was accessed by the technical developers.

The technical aspects of MOBIlearn were developed by a widely dispersed team of developers using service oriented architecture. Services were designed to communicate asynchronously using unstable communication channels (MOBIlearn, 2002). At the centre of the system is the component providing the portal services including a main portal component providing access to the entire system.

http://www.Management-Journal.com, ISSN 1447-9524 (print), 1447-9575 (online)

This represents the single access point for the user to all the services and learning objects provided by the MOBIlearn system.

This paper concentrates on the knowledge management applications of the system as illustrated by the health care scenario. The activity where learners are required to evaluate an incident presented visually on their mobile devices will be examined in detail in terms of knowledge management theory.

In the health care domain, learners are encouraged to share practises and discuss possible solutions to problems which they encounter. The contribution of the MOBIlearn systems methodology in encouraging the development of communities of practice and learning organisations will be discussed.

Virtual Communities of Practice

A community of practice has been defined as "... a flexible group of professionals, internally bound by common interests, who interact through interdependent tasks guided by a common purpose thereby embodying a store of common knowledge"; (Jubert, 1999: 166). In the health care environment, paramedics clearly fall under this definition. However, when you consider Ellis et al (2003), not all the criteria suggested are strictly met for health care workers, for example, the concept of a voluntary and emergent group of individuals and self regulation. By the nature of the profession, the community cannot be self regulating and it is arguable whether membership is voluntary.

Other criteria are less controversial, for example, mutual sources of gain, shared practices, mutual trust and tacit understanding of common interests and issues of concern.

MOBIlearn is primarily about learning. However, core to the methodology is an assumption that users will work in a collaborative way, no matter which scenario is being considered. For an e-learning system to encourage the formation of a community of practice it is useful to consider the guidelines of Desanctis et al (2003) who suggest collaborative learning should:

- aim for frequent interactions
- foster the technology as a platform for group discourse
- aim for deep discussion (over time)
- recognise the importance of facilitators
- recognise the importance of routines
- encourage groups to experiment

All of these points relate to features found in MOBIlearn and which encourage the formation of a community of practice. The first point is particularly important as Koh and Kim (2004) reported that the amount of interaction, specifically knowledge sharing, is an indication of the state of health of a community.

Learning

Engagement, learning and transfer are, according to Waight and Stewart (2005), the major outcomes which can be achieved via e-learning. MOBIlearn provides a tool to facilitate collaboration and teamwork. It expands on systems such as OTIS (Occupational Therapy Internet School) (Beer et al, 2005) where occupational therapy students from across Europe came together to discuss the practice of their subject in each country. The objective of OTIS was for students to identify similarities and differences in their practices based on a series of case studies.

MOBIlearn provides a framework which can be used in variety of learning situations. It allows a variety of learning styles and can be delivered on mobile computing devices ranging from laptop computers to smart phones. Learners today want to learn when and where they want, in formal, non-formal and informal ways (Brand et al, 2002, Cook and Smith, 2004).

The types of learning, shown in Figure 1, are characterised by the following attributes:

- Formal
  - Mandatory participation
  - Objectives and means controlled by a facilitator
- Non-formal
  - Voluntary participation
  - Objectives controlled by learners
  - Means controlled by a facilitator
- Informal
  - Grows out of spontaneous situations
  - Objectives and means controlled by learners
  - There may be a facilitator who may provide some content and moderation

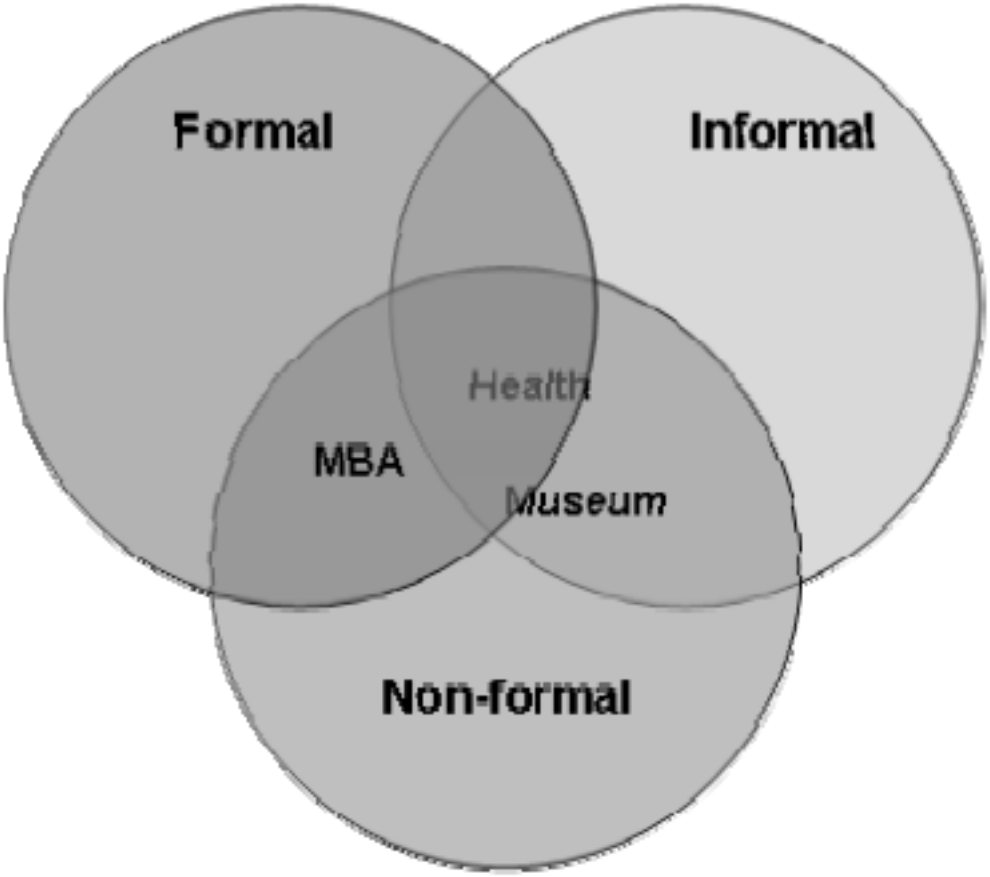

Figure 1: Learning and the Position of the MOBIlearn Scenarios

The Health Care Scenario

Harun (2002) states that there is a constant need to rapidly train employees and update their skills in all types of working environments, and especially in the healthcare environment. It is further stated that e-learning and knowledge management are core to achieving this. Young (2003) provides the example of e-learning to improve leadership skills among nurses. The majority of nurses preferred engaging with material at home and over the internet in their own time and own pace. A survey of the nurses suggested a high percentage had applied the knowledge they had gained. MOBIlearn aims to develop skills by providing ubiquitous access to learning so a health care worker can learn when and where it suits them.

The health care scenario is a non-formal learning environment where a community of practice is being encouraged. The system is designed to deliver a variety of content ranging from reference material to training case studies which can then be discussed and developed. Learning has no start or end point and new members can join (and leave) at any time, however it may be a condition of employment that staff engage with the activities as part of their continuing professional development. As already stated, this does contradict some of Ellis et al's (2003) criteria for a community of practice, specifically a voluntary and emergent group. However, if staff members engage with the learning environment, a virtual community of practice could develop meeting other criteria including a mutual source of gain. Users are motivated by their own interests as well as the organisations interests (Cook and Smith, 2004). It is an example of a sponsored community.

Within the health care scenario, a quiz game, visualisation activity, enactment and self-evaluation were all required as well as the more generic requirements of the MOBIlearn system as a whole. Figure 2 shows a use case diagram, a UML (Unified Modelling Language (Rumbaugh et al (1999)) model which documents user requirements for the health care scenario. Some of these were common to the other scenarios. The health care requirements could be grouped into the following categories with the associated learning types described earlier

- Connect to the system
- Collaborate (informal, non formal)
- Manage Material (informal)

- Case Study Scenarios (non formal, formal)
- Quiz Management (non formal, formal)
- Locate assistance

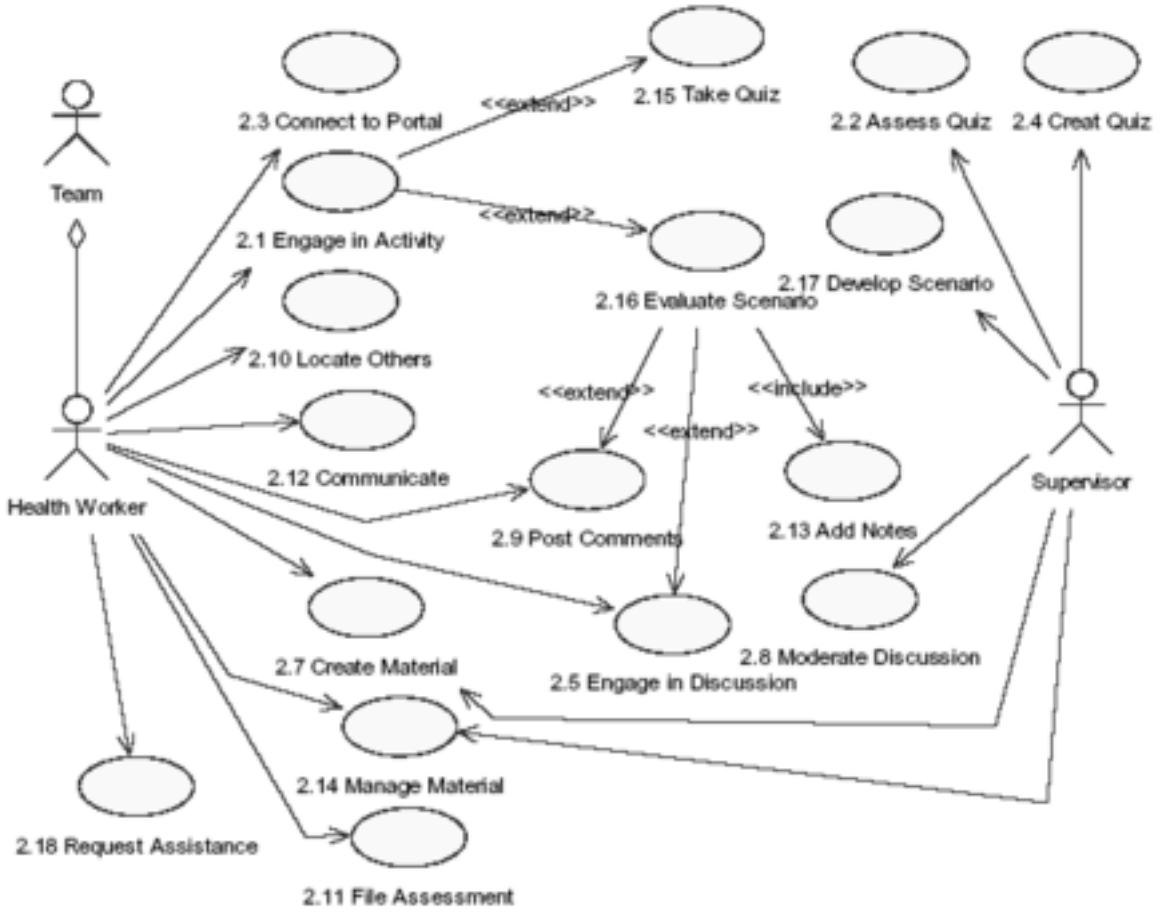

Figure 2: Use Case Diagram of the Health Care Scenario

Therefore, although primarily a non-formal learning environment, the health care scenario has elements of both formal and informal learning associated with it. There are basic proficiencies, skills and responses to situations which must be learned. These can be delivered by the quiz and the evaluation of a case study. Using criteria based assessment, a health worker could improve their certification. This is formal learning and will need to be validated by appropriate professional bodies if it is to be used as such.

There is also an informal component where health workers with particular interests could develop their knowledge in a more spontaneous and unstructured way. Again individuals and groups could develop a knowledge base in a specific type of case study rather than a broad range.

The system also allows reference material to be created and managed. For example a user can call up instructions on how to deal with minor wounds. The template used for detailing the procedure is illustrated in figure 3.

Condition	**Minor wounds**
Aim:	Prevent **infection**
Treatment:	• wash and dry your **own hands** • cover any **wounds** on your own hands • put on **disposable gloves** • clean wound, if dirty, under **running water** • **pat dry** with **sterile dressing** • cover wound temporarily with sterile dressing while you clean surrounding skin with soap and water • always swab **away** from the wound, using a fresh dressing for each stroke pat surrounding skin dry • cover **wound** completely with **sterile dressing** • advise **casualty** to see doctor if there is a special risk of **infection** because, for example, the **wound** was caused by an **animal bite** a dirty object (puncture wound)
	Remember – there is a risk of infection by tetanus for ALL open wounds

Figure 3: Template for Instructions Illustrated by 'Minor Wounds'

Material developed as part of the discussions of the visualisation case study, described in detail below, could become part of the reference material after discussion and validation. If this was the case it could be described using the template and added to the system.

An Example of a Case Study

One of the activities in the scenario is 'visualisation', or as labelled in the use case diagram, 'Evaluate Scenario'. This is designed to test a variety of skills of an individuals and teams of individuals. In the requirements scenario it is presented as:

"....Gill receives a picture of a first aid event. .... The picture is accompanied by a text message asking her to scrutinise the picture, and file an initial assessment ...." (MOBIlearn, 2002, p 17)

Specifically it aims to:

- improve observation and appraisal skills,
- improve decision making under pressure,
- encourage learners to examine their response,
- facilitate collaboration with other learners.

An example of how a case study would be presented to a learner is shown in Figure 4 where an incident has been staged. Learners are stepped through the incident and are required to give an assessment at each stage. This assessment can then be discussed by other members of the community.

Figure 4 shows the first of three images in the case study 'collapse 2' which involves an incident of a collapsed unconscious IT worker. It was discovered during evaluation that a series of still images was more effective than a video clip for a user to add observations and assessments. Each subsequent image shows a relevant section of the case study in close up and allows further assessments to be made and refined. For example, the last image shows, in close up, the victims' hand is touching the computer frame.

Figure 4: PDA Based Version of the Learning Object 'Collapse 2

Visualisation case studies were documented using the template illustrated in figure 5. This structure allows a case study developer who has no experience in developing web based material to specify requirements to the content developer along with images which can be used.

Once a team member has completed their assessment, other members of the team can comment on the assessment, adding extra observations, pointing out possible problems and evaluating the overall process. For example, during testing, in the visualisation case study illustrated in figure 4, an initial evaluation of the scene produced a variety of responses from learners including: the subject was taking a nap, had been electrocuted and had suffered a heart attack, all of which were possible. However discussion of

the responses to the scenario revealed that it initially had to be assumed it was a case of electrocution and the environment had to be made safe (if the equipment was still 'live', a rescuer could be come a second victim by touching the subject). This came about from a discussion on how to determine if the subject was asleep and the dangers posed by shaking him.

Currently the case studies are created and moderated by a supervisor, but learners could be encouraged to create their own case studies using the visualisation case study template.

Title	collapse at work 2
Description	set of 3 pictures giving close-up view of male IT worker collapsed in IT room for incident assessment practice
Keywords	health, first aid, incident, collapse, IT worker, computer, unconscious, tools, electricity, incident assessment
Description of display required:	
Show as screen with image + text instruction + navigation button (next) Start should: show image *collapse 2a* - image of scene instruction " create an initial assessment of the scene then click next" next should: show image *collapse 2b* - closer view of scene instruction " add any additional comments to your assessment of the scene then click next" next should: show image *collapse 2c* - close-up of computer and tools instruction " add any final comments to your assessment of the scene then post findings" end	

Figure 5: Template for Visualisation Case Study Illustrated by 'Collapse at Work'

Learning in a healthcare environment using the visualisation case study is consistent with the models of Nonaka and Tecuchi (1995) and Nonaka et al (2000) where learning is regarded as a transition between individual and group tacit and explicit knowledge. This knowledge is developed as a learning spiral.

MOBIlearn is a system which facilitates this type of learning. Assessment of case studies requires a learner to apply explicit knowledge to a new situation. This may lead to the development of new tacit knowledge in the individual. The discussion phase - socialisation in the model - is the stage where the tacit knowledge is refined and made more explicit. If the case study results in a new procedure accepted by peers and the health care organisation, it can be added to the system as reference material. For example, in the case described above, the first step of any response is to secure the environment by making sure there are no potentially live electrical devices touching a subject. In some environments this could be widened to other hazards, for example gas or chemical spills. The cycle then continues with the new explicit knowledge being applied to new case studies by an individual learner.

Learning facilitated by MOBIlearn is also consistent with the view of Cook and Brown (1999) who described the relationship between knowledge and knowing, where knowing is an aspect of interaction with the social and physical world. They further state that there is a 'generative dance' between knowing and knowledge which results in new knowledge and

innovation. In the visualisation exercise, learners are being exposed to a virtual representation of the physical world as well as virtual social interaction with other learners. The result may be the generation of new knowledge as described above.

Conclusions

The MOBIlearn prototypes objective was to provide effective communication to the learner as they moved around a real scenario. In many ways this could be compared with turning the real world into a virtual reality type of experience. The use of mobile phones and PDAs to communicate meant that learners were fully aware of and familiar with the use of the communications facilities from the start and communicated freely both to share experiences and to leave comments as they moved around the real environment. So, for example, in the museums scenario this led to what was effectively the sticking of post-it notes with comments on some very well known paintings. These shared views became a major part of the learning experience. The healthcare scenario described in detail in this paper was very much an attempt to guide learners through particular scenarios required by competency programmes aimed at providing confidence in dealing with certain types of situation that a first aider is likely to find in the real world. The objective was therefore to deliver the training as it was required, without the learner having to wait for the next available face-to-face course but without loosing the learning associated with the conventional group interactions and peer support.

This paper has concentrated on the knowledge management principles and the facilitation of communities of practice embodied in the health care scenario of the MOBIlearn project. Although it is not possible for management to create a community of practice, MOBIlearn encourages it by providing both a technological infrastructure and a methodology to exploit it by providing templates to create learning objects.

In terms of organisational learning, MOBIlearn provides an infrastructure to facilitate learning consistent with both the knowledge spiral of Nonaka et al (2000) and the generative dance between knowledge and knowing of Cook and Brown(1999). A method of knowledge transfer from individual to organization can be implemented. MOBIlearn also provides a mechanism for individuals to interact with a virtual representation of the physical and social world.

Learning in health care is primarily concerned with non-formal learning but also has elements of formal and informal learning. Central to knowledge creation and sharing is the visualisation of an incident which a learner has to evaluate and then discuss with other learners. This requires the application of existing knowledge, and promotes the generation of new knowledge which can then be added to the reference component of the system. The system therefore facilitates learning by translation of tacit into explicit knowledge which can then be retained as a reference. Existing knowledge is constantly reviewed as it is applied to the new incident case studies.

Acknowledgements

We acknowledge the EU for financial support through the MOBIlearn project (IST-2001-37440). The views expressed in this paper are those of the authors and may not represent the views of the EU. We would specifically like to acknowledge Mr Terry Keefe, one of the MOBIlearn team, who developed the content for the health care scenario.

References

Beer, M, Slack, F. and Armitt, G., (2005), 'Collaboration and teamwork: Immersion and presence in an Online Learning Environment', *Information Systems Frontiers*, Vol. 7 (1), pp. 27- 35.

Beynon-Davies, P. and Holmes, S., (2002), 'Design breakdowns, scenarios and rapid application development', *Information and Software Technology*, Vol. 44, pp. 579–592.

Brand, O., Petrak, L. and Zitterbart, M. (2002), 'Support for Mobile learners in Distributed Space', Learning Lab Lower Saxony (L3S), accessed on 11/07/03, www.learninglab.de/~brand/Publications/elearn02.pdf

Cook, J. and Smith, M., (2004), 'Beyond formal learning: Informal community eLearning', *Computers and Education*, Vol. 43, pp. 35-37.

Cook, S. D. N. and Brown, J.S., (1999), 'The Generative Dance between Organizational Knowledge and Organizational Knowing', *Organization Science*, Vol. 10(4), pp 381-400.

Desanctis, G., Fayard, A-L., Roach, M. and Jiang, L. (2003), 'Learning in Online Forums', *European Management Journal*, Vol. 21(5), pp. 565 - 577.

Ellis, D., Oldridge, R. and Vasconcelos, A., (2003), 'Community and Virtual Community', In Cronin, B. (Ed.) *Annual Review of Information Science and Technology*, Vol. 37, pp.145-146.

Fernandes, K. J., Raja, V. And Austin, S. (2005), 'Portals as a knowledge repository and transfer tool – VIZCon case study'. *Technovation*, Vol. 25, 1281-1289.

Jubert, A., (1999), 'Developing an infrastructure for communities of practice: the Siemens experience'. *Proceedings of the 3rd International Online Information Meeting, Online Information 99*. London. pp 165 - 158.

Kambourakis, G., Kontoni, D. N., Rouskas, A. and Gritzalis, S. (in press), 'A PKI approach for deploying modern secure distributed e-learning and m-learning environments' [electronic version]. *Computers and Education*.

Kinshuk and Goh, T., (2003), 'Mobile Adaptation with Multiple Representation Approach as Educational Pedagogy', *Proceedings of Wirtschaftsinformatik 2003 - Medien - Markte - Mobilitat*, Heidelberg, Germany. pp.747 - 763.

Koh, J. and Kim, Y. -G., (2004), 'Knowledge sharing in virtual communities: an e-business perspective', *Expert Systems with Applications*, Vol. 26, pp. 155-166.

Loidl, S., (2005), 'Towards pervasive learning: WeLearn.Mobile. A CPS package viewer for handhelds', *Journal of Network and Computer Applications*, in press (electronic version available through Elsevier ScienceDirect http://www.sciencedirect.com)

MOBIlearn (2002), 'Next Generation paradigms and interfaces for technology supported learning in a mobile environment exploring the potential of ambient intelligence, Annex 1', Information Society Technologies Program EU Proposal/Contract: IST-2001-37187.

Nonaka, I, Toyama, R., Konno, N (2000), 'SECI, *Ba* and leadership: a unified model of dynamic knowledge creation', *Long Range Planning*, Vol. 33(1), pp 5 - 34.

Nonaka, I.; Takeuchi, H. (1995), The Knowledge-Creating Company : How Japanese Companies Create the Dynamics of Innovation. New York: Oxford University Press

Robertson, J. and Robertson, S. (2001). *'Volere: Requirements Specification Template'*, 8th ed., Atlantic Systems Guild.

Rumbaugh, J., Jacobson, I. and Booch, G. (1999), *The Unified Modelling Language Reference Manual*, Addison Wesley.

Stone, A. (2003), 'Designing Scalable, Effective M-Learning for Multiple Technologies', *Proceedings of MLEARN 2003: Learning with Mobile Devices*, London, United Kingdom. pp. 145 - 153.

Taylor, J. (2003), 'A Task-centred Approach to Evaluating a mobile Learning Environment for Pedagogical Soundness', *Proceedings of MLEARN 2003; Learning with Mobile Devices*, May, London.

Waight, C.L. and Stewart, B.L. (2005), 'Valuing the adult learner in e-learning: part one - a conceptual model for corporate settings', *The Journal of Workplace Learning,* Vol. 17, pp 337 - 345.

Xu, D., Wang, H., and Wang, M., (2005), 'A Conceptual Model Of Personalised Virtual Learning Environments', *Expert Systems with Applications*, Vol. 29, pp 525-534.

Young, K. (2003), 'Using e-learning to liberate the talents of nurses', *Industrial and Commercial Training*, Vol. 35 (4), pp 137-141

About the Author

Dr Paul Crowther

I am a principal lecturer in charge of the Information Systems subject group at Sheffield Hallam University. My research interests are in knowledge base systems, particularly knowledge acquisition techniques. I have published widely in this field, particularly the capture and structuring of visual knowledge. Since my move from the University of Tasmania to Sheffield Hallam University, I have moved into the area of knowledge management. My most recent work has been associated with the European Union funded MOBIlearn project where I have been involved in requirements analysis and the use of the system as a knowledge management tool.

THE INTERNATIONAL JOURNAL OF KNOWLEDGE, CULTURE AND CHANGE MANAGEMENT

Please visit the Journal website at http://www.Management-Journal.com for further information:

- ABOUT the Journal including Scope and Concerns, Editors, Advisory Board and Associate Editors
- FOR AUTHORS including Publishing Policy, Submission Guidelines, Peer Review Process and Publishing Agreement
- JOURNAL PROFILE including Statistics/Citations and where the Journal is indexed/abstracted

SUBSCRIPTIONS
The Journal offers individual and institutional subscriptions. For further information please visit http://ijm.cgpublisher.com/subscriptions.html. Inquiries can be directed to subscriptions@commongroundpublishing.com

INQUIRIES
Email: cg-support@commongroundpublishing.com